Review Article

A variety of teaching interventions to improve bovine transrectal palpation training

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Abstract

Pregnancy diagnosis by transrectal palpation (TRP) is a frequently performed procedure in bovine practice and an important competency for veterinary graduates. Student training for these skills has been identified as challenging, and reported training outcomes highlighted that students' pregnancy diagnosis accuracy was an area that needed improvement. This led to a series of investigations evaluating specific teaching approaches aimed at optimizing TRP training and improving learning outcomes while decreasing the number of palpations needed to become competent, or in other words to 'fast-track' the transrectal palpation skill learning process. Gathered data were used to develop and implement research-based innovative teaching ideas, including optimized simulator training, in-training assessment methods, additional training opportunities linked to or not directly linked to the TRP skill itself, and the use of technology to improve skills training. This paper is a summary of these teaching interventions and elaborates on the background of those and why implementation is expected to improve student competence. Furthermore, even though the investigations described here are specific to bovine TRP and pregnancy diagnosis skills, they highlight an approach that can be applied to other clinical hands-on skills.

Keywords: Transrectal palpation, bovine pregnancy diagnosis, competency, clinical skills training

Introduction

Bovine pregnancy diagnosis (PD) via transrectal palpation (TRP) is a frequently performed procedure in bovine practice,[1] of economic importance,[2–11] and an important competency for veterinary graduates.[12] Training of bovine TRP and PD is challenging, however, as it requires extensive exposure to TRP in live cows to achieve competency.[13–16] Veterinarians often refer to the anecdotal 'magic 10,000,' that is the number of rectal palpations assumed to be necessary to ensure palpation competence. The origin of this number is unknown but indicates the perceived amount of practice necessary to confidently perform bovine PDs. It is possible that it is a link to Ericsson's concept of deliberate practice where a practice time of at least 10,000 hours is stipulated to lead to expert status in a specific skill.[17] The Australian Veterinary Association also previously recommended a minimum of 2,000 live cow palpations before attempting the competency examination.[18,19] Some publications evaluated students' TRP and PD performance after training and how many palpations are required to ensure competence,[13–15,20] and it was suggested that 200 live cow palpations were insufficient to establish TRP competence for all 10 students in the evaluated group.[13] Compared to many other skills, TRP and PD training is further complicated by the nature of the procedure; demonstration of the technique by an instructor and observation of a student palpating a live cow are not possible as execution of the procedure cannot be seen.[13,16,19,21] In addition to these challenges, veterinary schools are expected to graduate entry-level veterinarians with advanced skills,[22,23] while welfare and ethical concerns about the use of live animals for training purposes, large student cohorts, budget constraints, and difficulty sourcing cadaver material limit hands-on experience and training opportunities in general,[22,24–35] thus influence PD training for veterinary students at teaching institutions due to a shortage of palpation opportunities.[13–16,21] Furthermore, it seems difficult for students to get additional bovine PD and TRP exposure outside the veterinary course.[15,36] Described training strategies to overcome some of the challenges listed above are exposure to abattoir-derived organs followed by live cow palpations,[19,36] the use of cows at abattoirs prior to slaughter,[15] student exposure to bovine TRP and PD during extramural studies,[16,21] or ambulatory clinic rotations,[15,21] and the use of a computer-assisted learning tool.[19] Furthermore, a variety of rectal examination simulators such as the Veterinary Simulator Industries' bovine

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theriogenology model,[a] Minitube's 'Henryetta' model,[b] the Breed'n Betsy® rectal examination simulators,[c] and the Haptic Cow[d] are commercially available, and several studies evaluated the use and implementation of rectal examination simulators in veterinary training programs.[13,16,36–40]

While training of bovine TRP and PD has been identified as challenging,[13–16,19] only limited data were available on student performance in bovine TRP and PD.[13,14] Recent investigations into TRP and PD training outcomes highlighted that students' PD accuracy was an area that needed improvement.[36,41,42] This led to a series of projects evaluating specific teaching approaches aimed at optimizing TRP training and improving learning outcomes while decreasing the number of palpations needed to become competent, or in other words to 'fast-track' the TRP skill learning process.[43] Gathered data were used to develop and implement research-based innovative teaching ideas, including optimized simulator training, in-training assessment methods, additional training opportunities linked to or not directly linked to the TRP skill itself, and the use of technology to improve skills training.

Recommended evidence-based teaching approaches

The teaching approaches are listed below. This paper elaborates on the background of those and why implementation is expected to improve student competence for bovine TRP and PD. For the context of this paper, sensitivity of PD is defined as students' ability to correctly identify pregnant cows, whereas specificity is defined as students' ability to correctly identify non-pregnant cows.

In summary, we recommend:

1. Repeated rectal examination simulator-based training in conjunction with live cow exposure early in the curriculum.
2. Teaching efforts focusing on specificity of PD.
3. Teaching efforts focusing on stage corrected sensitivity and early pregnancy stages.
4. Encouraging students to use an exercise program like the 'bovine pregnancy diagnosis improvement exercise program' (http://icarus.up.ac.za/vetmlp/) to improve grip strength and indirectly palpation abilities.
5. Use of the 'mini-cow palpation box' to develop coordination and fine motor skills to estimate object sizes without visualization.
6. Introduction of a TRP objective structured clinical examination (OSCE) (on simulator and/or non-pregnant live cows, depending on availability) as a compulsory formative in-training assessment ('rite of passage' examination) before advancing to PD training on live cows.
7. Use of the validated TRP OSCE on non-pregnant live cows as well as a validated PD assessment on live cows to ensure training outcomes and track student progress during advanced TRP and PD training sessions.
8. Implementing focused access to live cow palpations for students with an interest in production animal practice during later stages of the curriculum.
9. Ensuring supervision and quality feedback during palpation sessions.

Repeated rectal examination simulator-based training in conjunction with live cow exposure early in the curriculum

The first recommendation is based on a validation study comparing rectal examination simulator versus live animal PD training.[36] It revealed that students' ability to detect pregnancy in cows > 6 months pregnant was similar for training on simulators and live cows. However, PD training on simulators, compared to training on live cows, was associated with lower student PD sensitivity for cows < 6 months pregnant. This was an interesting outcome since the Breed'n Betsy® simulators are specifically designed for early pregnancy detection and also because the live cows used for training purposes in that study were all > 6 months pregnant.[36] A potential reason for this paradox was thought to be that overcoming the unusual experience of TRP may be more difficult than the actual ability to palpate.[36] Absence of rectal peristalsis, anal sphincter tone, and other internal organs (e.g., urinary bladder and rumen) make reproductive tract palpation easier on a simulator than in the live animal, and the simulator experience may not impart the feeling of palpating a live cow. Also, simulator palpations were suspected to require various arm movements and muscle activations than the same procedure on live animals. While a follow-up investigation to elaborate on this hypothesis concluded that there is no difference in muscle activation for simulator and live cow palpations, it revealed that muscle relaxation between individual TRP steps for simulator palpations was more distinct for simulator compared to live cow palpations. This was thought to be due to the absence of rectal peristalsis in simulators, and a potential reason for a difference in simulator and live cow training outcome. While it was demonstrated that rectal examination simulators cannot replace live animal training, implementation of simulators into veterinary teaching programs offers remarkable additional training opportunities beyond live cow training that can help reduce the requirements of live animal training. These findings were in accordance with other studies evaluating the use and implementation of rectal examination simulators in veterinary training programs.[13,16,37–40] In the case of TRP and PD, simulator training was superior to theoretical instruction only,[39] and additional simulator training substantially improved students' performance after live cow palpations.[16] Therefore, repeated simulator-based training in conjunction with live cow exposure is recommended to optimize learning outcomes.[13,16,36,39] Another finding related to the use of simulators is that timing of simulator training in relation to student experience within the veterinary course is important.[20,36] The proposal of simulator training early in the curriculum stems from student feedback where 4th year students (of a 6 year course) without any prior live cow PD experience were exclusively positive about their simulator experience, whereas students with previous live cow PD experience made negative remarks about the simulator exposure.[36] This finding was endorsed by final-year student questionnaire feedback showing that refresher rectal examination simulator training at these later stages in a student's career was not perceived as beneficial by the majority of students.[20] It has previously been described that satisfaction data should be considered, as student perceptions of a model will affect their motivation to use it.[44,45] Since students felt the model was useful at a specific

[a] Veterinary Simulator Industries, Calgary, Canada (https://vetsimulators.com/).
[b] Minitube Tiefenbach, Germany (https://www.minitube.com/).
[c] Breed'n Betsy® Victoria, Australia (http://www.breednbetsy.com.au/).
[d] Virtalis Ltd, Cheshire, United Kingdom (https://www.virtalis.com/haptic-cow/).

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point in their veterinary education, they will likely be motivated to practice on it.[44] Enjoying a procedure enhances positive emotions that have been reported to facilitate successful learning.[46] Therefore, rectal examination simulator training should be implemented early in the curriculum before but in conjunction with live cow exposure.

Teaching efforts focusing on specificity of PD

PD specificity is defined as the students' ability to correctly identify non-pregnant cows. Correctly and reliably identifying non-pregnant cows is especially important for farmers due to the economic implications of a false positive PD. While students are not expected to be at the same competence level as experienced practitioners, a specificity of 41 and 42% reported for 4th and 5th year students, respectively, had been identified as a problem area,[36,41,42] and teaching efforts focusing on specificity of PD are recommended. Strategies to accommodate this part of the training are repeated simulator training exposure before live cow access, assessment of basic palpation skills before advancing to live cows, and demonstrating competence in non-pregnant cow palpations before advancing to PDs. This approach increased student specificity to 67%.[20]

Teaching efforts focusing on stage corrected sensitivity and early pregnancy stages

The stage of pregnancy is one of the factors associated with students' bovine PD accuracy. While overall PD sensitivity can be defined as correctly identifying pregnancy, stage corrected sensitivity takes the pregnancy stage into consideration. This has been defined as correctly identifying the stage of pregnancy within 1 month of the actual stage of pregnancy for all pregnancy stages up to 4 months, and within 2 months of the actual stage of pregnancy for pregnancy stages beyond 4 months.

While the mean overall reported student PD sensitivity was 61 and 82%, stage corrected sensitivity was only 31 and 43%, respectively (in the same cohort of students).[36,42] Furthermore, students' sensitivity of pregnancy detection was repeatedly higher for cows more than 6 months pregnant.[36,42] This confirms the need to concentrate training efforts on palpations during early pregnancy stages.

Encouraging students to use an exercise program like the 'bovine pregnancy diagnosis improvement exercise program' to improve grip strength and indirectly palpation abilities

The fairly unusual and tiring physical activity of bovine TRP sparked an idea for a novel approach to improve students' TRP and PD skills. The effect of a physiotherapy exercise program on students' TRP and PD skills was evaluated.[42] The 2 main findings were that students who participated in the exercise program and students who had a grip strength of more than 30 kg performed better in PDs. Results from this investigation initiated a subsequent electromyography (EMG) study taking these findings a step further and led to the development of the 'bovine PD improvement exercise program.'[47] The EMG study suggested that hand muscles, extensors and flexors of the forearms, shoulder stabilizers, back muscles, and core muscles are strongly activated during TRPs, confirming the role that forearm muscles, and therefore grip strength, play during TRP.[42,47] It was also apparent that muscle endurance is more important than total muscle strength. Based on these findings, a 3-month exercise program targeting exactly those muscle groups was developed with the help of an experienced biokineticist.[47] The program is divided into 3 levels starting with easier entry level exercises and building up to more advanced exercises. It is available to students via the following link: http://icarus.up.ac.za/vetmlp/. The program uses readily available exercise equipment and is suitable to any exercise level, and instructions are given through narrated video clips (Figure 1). This online program enables students to choose when and where they would like to exercise and only requires the participant to exercise for 30 minutes, 3 times a week. It can be done in conjunction with any other fitness or exercise activity. The program not only increases grip strength and therefore indirectly improves TRP accuracy but also increases stamina and wellbeing, shapes arms nicely, and adds some fun to busy study schedules.

Part of implementing this intervention should be student awareness of the critical threshold for grip strength,[42] and what their own grip strength is at the onset of TRP and PD training. If this is done early enough, it might increase student motivation and drive to execute an exercise program as described here to improve grip strength. Grip strength measurement is easily done using inexpensive commercially available dynamometers.[42]

Use of the 'mini-cow palpation box' to develop coordination and fine motor skills to estimate object sizes without visualization

Results of a recent study[41] suggested that bovine TRP OSCE scores can predict students' future PD accuracy, and students' ability to estimate ovarian size was positively correlated to PD sensitivity. Based on these findings, a 'mini cow palpation box', similar to a palpation box described,[14] was developed to supplement TRP training opportunities prior to students' first live cow TRPs.[41] It aims to develop coordination and fine motor skills in order to estimate object sizes without visualization. Three-dimensional objects of varying sizes from 2 to 8 cm are labeled with the correct length, width, and height measurements. The objects are placed in a large plastic box with hand entrance holes to ensure palpation and size estimation of objects without visualization (Figure 2). A ruler to measure finger width and instructions on how to use the palpation box are attached to the box. This additional teaching tool helps improve students' fine motor, TRP, and PD skills before their first live cow palpations and assists students to prepare for formative in training assessments as described earlier.

Introduction of a TRP OSCE (on simulator and/or non-pregnant live cows, depending on availability) as a compulsory formative in-training assessment ('rite of passage' examination) before advancing to PD training on live cows

It became apparent that students' ability to estimate ovarian size and to confirm the presence or absence of a corpus luteum was correlated with higher PD sensitivity,[41] whereas students' ability to confirm the presence or absence of a follicle was positively correlated with higher PD specificity.[20] Based on these results and the recommended approach to introduce a TRP OSCE as a formative assessment for ongoing feedback throughout the TRP training,[41] a compulsory in-training

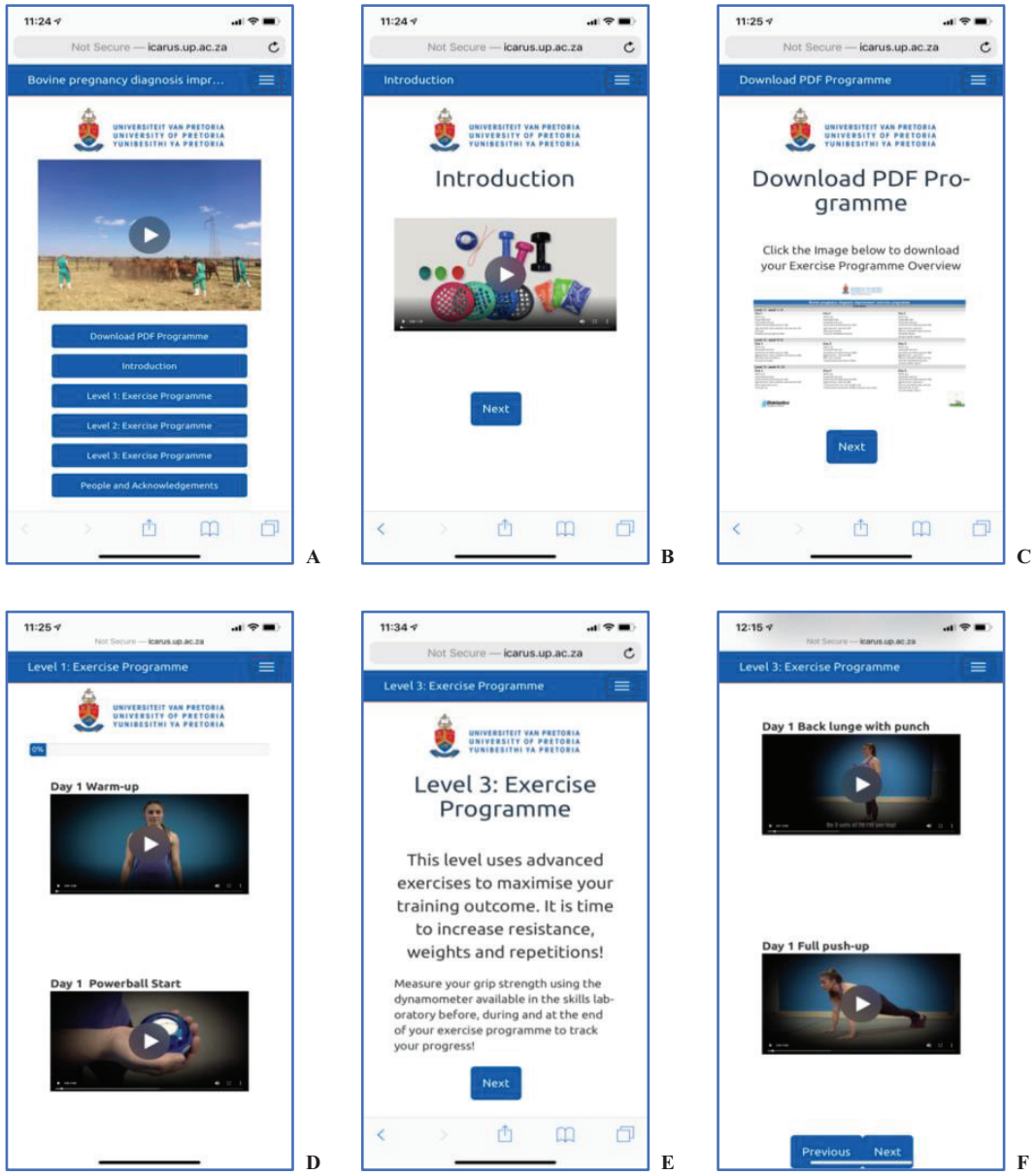

Figure 1*. Screenshots of the 'bovine pregnancy diagnosis improvement exercise program App' as seen on smartphone accessed through: http://icarus.up.ac.za/vetmlp/. (A) Homepage with the welcome video and all links of the exercise program. (B) Link with the introduction video to the exercise equipment. (C) Link to download the exercise program overview. (D) Link to exercise Level 1: videos demonstrating the exercises. (E) Links to the different exercise levels give additional information and remind users to track their progress via grip strength measurements. (F) Examples of 2 Level 3 exercises.
*source[47]

simulator OSCE assessment was implemented within the veterinary reproduction module at the Faculty of Veterinary Science, University of Pretoria, South Africa. During this assessment, students must palpate 3 Breed'n Betsy® simulator cows and fill in an OSCE sheet to indicate size of ovaries and the presence or absence of ovarian structures. Students can choose when they want to do the assessment and repeat the assessment as many times as necessary to pass. Passing this 'rite of passage' assessment is a requirement before students are allowed to advance to live cow palpations. The aim is to verify that students have demonstrated basic palpation skills before live cow access is granted to ensure more efficient live cow use. If rectal examination simulators are not available, a modified assessment can be implemented where students still must describe object sizes and identify structures resembling follicles or corpora lutea in a simulated setting.

Use of the validated TRP OSCE on non-pregnant live cows as well as a validated PD assessment on live cows to ensure training outcomes and track student progress during advanced TRP and PD training sessions

In order to evaluate training success, training outcomes have to be reliably measured. Previous studies describing

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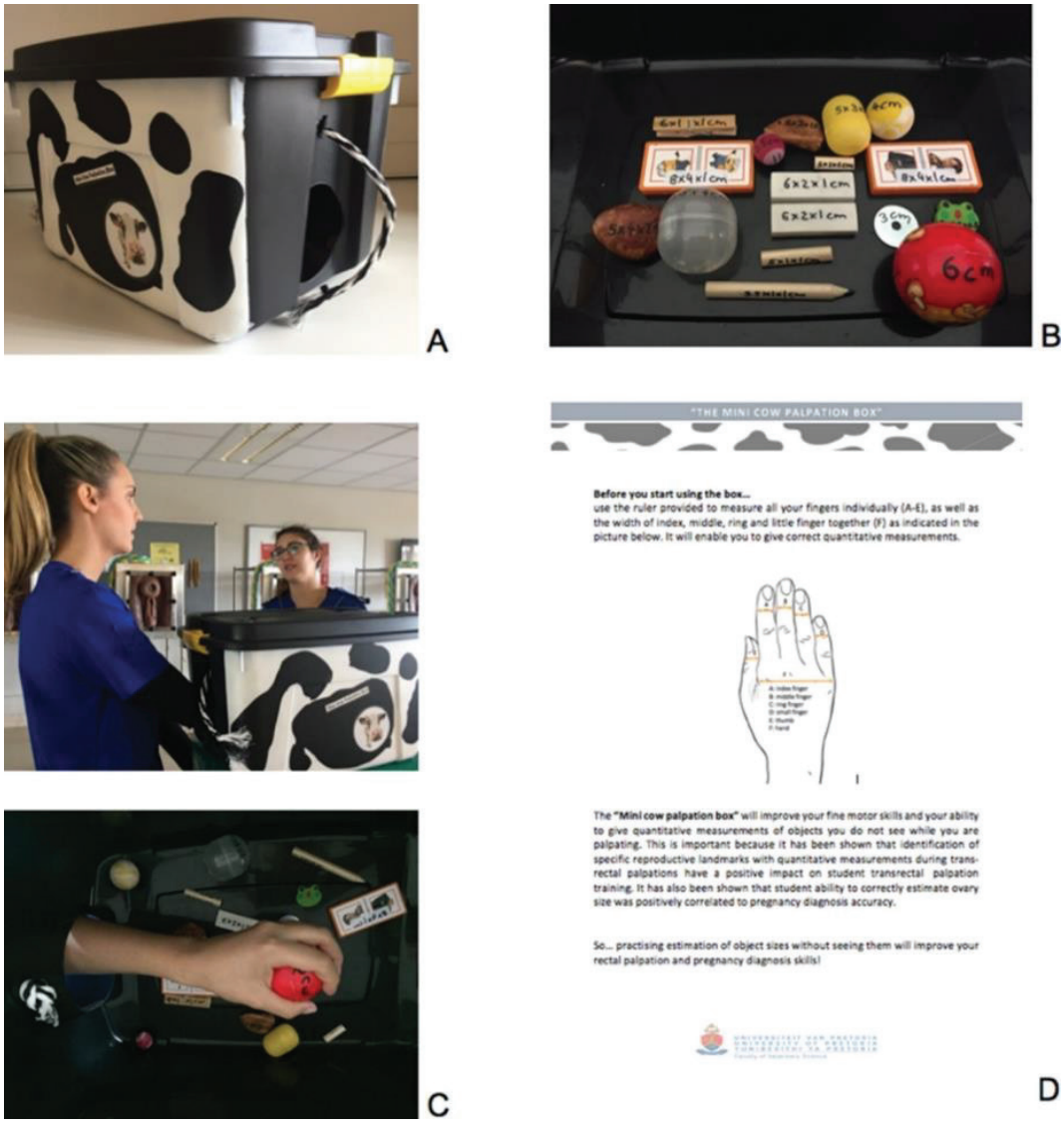

Figure 2*. 'Mini cow palpation box'. (A) Modified plastic box with hand entrance holes. (B) Three-dimensional objects of varying sizes inside the box. All objects are labeled with the correct length, width, and height measurements in centimeters. (C) Students using the palpation box. (D) Student instruction/information sheet on the palpation box.
***source**[41]

posttraining student performance in bovine TRP and PD involved small student cohorts, and TRP skills evaluation was based on various assessment criteria for each study.[13–15] To make outcome measurements more objective and repeatable, 2 TRP assessment methods were developed. The first described assessment measures of students' PD accuracy on live cows.[36] The set-up and execution was subsequently refined and optimized.[20,41,42] The second assessment is a TRP OSCE that had the ability to predict students' future PD accuracy.[41] It was also tested for validity and reliability.[41] Results suggested that students categorized to have competent palpation skills based on the overall score achieved in the OSCE were more likely to correctly identify non-pregnant cows (i.e., have better PD specificity), whereas students' ability to estimate ovarian size was positively correlated to PD sensitivity. Other individual OSCE components that were predictive of higher PD accuracy were students' ability to identify uterine position and diagnose absence of intrauterine fluid correctly.

These assessments can be implemented to ensure training outcomes and track student progress during advanced TRP and PD training sessions. Furthermore, using a combination of these 2 methods to evaluate students' TRP and PD skills (a TRP OSCE on non-pregnant cows followed by a structured assessment of PD accuracy in a real-life farm situation) can bridge the gap between practical competence and clinical performance of the same skill (TRP skills in this case).[48] This is important as OSCE assessments are conducted under simulated examination conditions, and they do not necessarily provide valid information on the candidate's ability to perform the skill in real-life situations.[48,49]

Implementation of focused access to live cow palpations for students with an interest in production animal practice during later stages of the curriculum

Usually only a small proportion of veterinary students are interested in food animal career.[36,41,50] Upbringing location,

gender, and previous pet ownership influence the career choice of veterinary students,[50–55] and 2 of the key demographics were positively correlated with a career in mixed or food animal practice: an upbringing on a small town or rural area and being male.[51,52,54,55] Work experience on a farm[54] and other agricultural exposure were positively associated with a preference for food animal employment.[50] An approach to improve PD accuracy for students truly interested in large animals is to create additional palpation opportunities and find practice placements for those students, which are ways to overcome the difficulty associated with large student cohorts. Focusing on smaller groups of students who will be more likely to use the skills was investigated in a study looking at the effect of a 1-week high-intensity training program on final-year veterinary students' PD accuracy.[20] This approach was successful as students' PD sensitivity and PD specificity were 88 and 67%, respectively. This was a notable improvement to 2 previous studies that had involved entire 4th and 5th year cohorts (Table).[36,42] Particular important is the improvement in specificity that had previously been identified as a problem area. Whereas students were previously only able to correctly identify 1 out of 3 non-pregnant cows,[36,42] it increased to 2 out of 3.[20]

The fact that the intense 1-week training program was at a later stage in the students' career when they would have been exposed to the initial TRP and PD trainings during their 4th year, followed by additional TRP exposure during clinic rotations and electives in their final year had an effective strategy on 2 distinct levels. First, more advanced veterinary students are expected to have more competent basic palpation skills, which makes intense training more effective. Second, targeting students interested in food animal practice decreases the cohort size and helps overcome the difficulty to find sufficient training and assessment opportunities.

Ensuring supervision and quality feedback during palpation sessions

Private practice placements were part of a study evaluating an intense 1-week TRP and PD training program.[20] The number of live cow palpations by students during the practice placements varied from 20 to 600. Fifty percent of students palpated <100 cows, and the other half palpated >100 cows. Interestingly, there was no correlation between the number of cows palpated during the private practice placements within the training program and posttraining TRP OSCE scores, or student PD sensitivity or PD specificity.[20] This is in contrast to previous findings where there was a positive correlation between number of cows palpated and students' TRP skills.[13] A possible explanation for this could be based on the concept of 'deliberate practice,'[17] which refers to 'intense, repetitive performance, in a controlled setting, of intended cognitive or psychomotor skills within a focused domain; rigorous skills assessment to identify deficiencies and errors; specific, informative feedback on how to correct them; and ongoing practice, with progressive increases in level of difficulty, yielding gradual, continuous improvement in skills performance'.[17,26,56] The effect of deliberate practice on expert status in many professional disciplines, including chess, athletics, music, and medicine, was made known,[17,57] and its importance for veterinary education has been highlighted.[26,58] Therefore, it is likely that the quality of supervision and feedback provided by the veterinarian might be more important than the number of cows palpated to improve TRP and PD skills. Students who palpated >300 cows during private practice placements probably received less feedback and supervision from the veterinarian due to time pressure compared to students who palpated fewer cows.[20] In support of this statement, student feedback highlighted the time and effort veterinarians took to teach them that was particularly evident among practice placements where fewer cows were palpated. This reasoning could be further substantiated by the fact that only previous TRP experience with a veterinarian was identified as a student level variable associated with a higher student PD specificity compared to previous student TRP experience without veterinary supervision,[36] underlining the effect of expert supervision. This highlights the importance of feedback and supervision and is a strategy to decrease the number of live cow palpations necessary to achieve competency.[43] This aspect should also be communicated when establishing relationships with private practitioners for student training. Arrangements for sufficient supervision and feedback should be a vital part of private practice placements.

Conclusion

This teaching tip demonstrates how training innovations can be combined with traditional training to optimally prepare students for limited live animal exposure. The aim was not to replace live animal training but to fast-track student skills as an effective approach to compensate for a shortage of live animal training opportunities. It demonstrates how research-based innovative teaching ideas, assessment methods, and additional training opportunities linked to or not directly linked to the skill itself, and the use of technology can be implemented to improve skills training. It also highlights that collaborations with experts in other fields, like physiotherapists, biokineticists, and information technology staff in our case, can help advance new and alternative ideas. While the investigations described here are specific to bovine TRP and PD skills, it is an approach that can be applied to many other clinical hands-on skills.

Conflict of interest

Authors have no conflicts of interest to report.

Table. Overall student PD accuracy, sensitivity, and specificity for 4th, 5th, and final-year student cohorts

Year	2014[36]	2016[41]	2018[20]
	4th yearstudent cohort	5th yearstudent cohort	Final yearstudent cohort
Overall student PD accuracy (%)	71	61	82
Sensitivity (%)	87	79	88
Specificity (%)	41	42	67

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Authors' contribution

Annett Annandale: Conceptualization, writing, review, and editing.

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